

I claim:

1 1. A rotary actuator comprising:
2 an actuator shell;
3 a planetary cage, disposed within the actuator shell;
4 a prime mover having a first prime mover portion rigidly
5 fixed to the actuator shell and a second prime mover portion,
6 adjacent to, and movable with respect to, the first prime mover
7 portion, rigidly fixed to the planetary gear cage, and capable
8 of exerting a torque on the first prime mover portion;
9 a cross-roller bearing having a first bearing portion
10 rigidly fixed to the actuator shell and a second bearing
11 portion, movable with respect to the first bearing portion;
12 an output attachment plate rigidly fixed to the second
13 bearing portion;
14 a shell gear rigidly fixed to the actuator shell;
15 an output gear rigidly fixed to the output attachment
16 plate; and
17 one or more planetary gears, disposed in the planetary
18 cage, each having a first gear portion meshed to the shell gear
19 and a second gear portion, adjacent to the first gear portion,
20 meshed to the output gear.

1 2. The rotary actuator of claim 1 further comprising a first
2 structural link rigidly connected to the actuator shell and a
3 second structural link rigidly connected to the output
4 attachment plate.

1 3. The rotary actuator of claim 2 wherein the first link and
2 second links are attached to the actuator shell and output
3 attachment plate, respectively, by quick-change attachment
4 structures.

1 4. The rotary actuator of claim 3 wherein each of the quick-
2 change attachment structures comprises a first radial groove in
3 the structural link, a second radial groove, adjacent to the
4 first radial groove, in the mating portion of the rotary
5 actuator, and a radial clamp, extending about the circumference
6 of the first and second radial grooves.

1 5. The rotary actuator of claim 2 wherein the first structural
2 link is attached to the actuator shell immediately adjacent to
3 the cross-roller bearing and the second structural link is
4 attached to the output attachment plate immediately adjacent to
5 the cross-roller bearing.

1 6. A rotary actuator comprising:
2 an actuator shell;
3 an eccentric cage, disposed within the actuator shell;
4 a prime mover having a first prime mover portion rigidly
5 fixed to the actuator shell and a second prime mover portion,
6 rotatable with respect to the first prime mover portion, rigidly
7 fixed to the eccentric cage, and capable of exerting a torque on
8 the first prime mover portion;
9 a cross-roller bearing having a first bearing portion
10 rigidly fixed to the actuator shell and a second bearing
11 portion, free in rotation with respect to the first bearing
12 portion;
13 an output attachment plate rigidly fixed to the second
14 bearing portion;
15 a shell gear rigidly fixed to the actuator shell;
16 an output gear rigidly fixed to the output attachment
17 plate; and
18 an eccentric, disposed about the eccentric cage, having a
19 first gear portion meshed to the shell gear and a second gear

20 portion, adjacent to the first gear portion, meshed to the
21 output gear.

1 7. The rotary actuator of claim 6 further comprising a first
2 structural link rigidly connected to the actuator shell and a
3 second structural link rigidly connected to the output
4 attachment plate.

1 8. The rotary actuator of claim 7 wherein the first link and
2 second links are attached to the actuator shell and output
3 attachment plate, respectively, by quick-change attachment
4 structures.

1 9. The rotary actuator of claim 8 wherein each of the quick-
2 change attachment structures comprises a first radial groove in
3 the structural link, a second radial groove, adjacent to the
4 first radial groove, in the mating portion of the rotary
5 actuator, and a radial clamp, extending about the circumference
6 of the first and second radial grooves.

1 10. The rotary actuator of claim 7 wherein the first structural
2 link is attached to the actuator shell immediately adjacent to
3 the cross-roller bearing and the second structural link is
4 attached to the output attachment plate immediately adjacent to
5 the cross-roller bearing.

1 11. The rotary actuator of claim 6 wherein one or more of the
2 first and second gear portions employs gear teeth having a
3 circular profile.

1 12. The rotary actuator of claim 11 wherein the gear teeth
2 having a circular profile are dimensioned to have a slight
3 interference.

1 13. The rotary actuator of claim 12 wherein one or more of the
2 gear teeth having a circular profile have a cavity disposed
3 therein in order to reduce the stiffness of the gear teeth.

1 14. The rotary actuator of claim 6 wherein 10 or more gear
2 teeth within one or more of the first and second gear portions
3 are in contact at any point in time.

1 15. A rotary actuator comprising:

2 an actuator shell;

3 a first planetary cage, disposed within the actuator shell;
4 a prime mover having a first prime mover portion rigidly
5 fixed to the actuator shell and a second prime mover portion,
6 rotatable with respect to the first prime mover portion, rigidly
7 fixed to the first planetary gear cage, and capable of exerting
8 a torque on the first prime mover portion;

9 a shaft, having a shaft gear rigidly fixed thereto;

10 a second planetary gear cage, rotatable with respect to the
11 first planetary gear cage and the shaft, having a cage gear
12 rigidly fixed thereto;

13 one or more first stage planetary gears disposed in the
14 first planetary gear cage, each having a first gear portion
15 meshed to the shaft gear and a second gear portion, adjacent to
16 the first gear portion, meshed to the cage gear;

17 a cross-roller bearing having a first bearing portion
18 rigidly fixed to the actuator shell and a second bearing
19 portion, free in rotation with respect to the first bearing
20 portion;

21 an output attachment plate rigidly fixed to the second
22 bearing portion;

23 a shell gear rigidly fixed to the actuator shell;

24 an output gear rigidly fixed to the output attachment
25 plate; and

26 one or more second stage planetary gears disposed in the
27 second planetary gear cage, each having a first gear portion
28 meshed to the shell gear and a second gear portion, adjacent to
29 the first gear portion, meshed to the output gear.

1 16. The rotary actuator of claim 15 further comprising a first
2 structural link rigidly connected to the actuator shell and a
3 second structural link rigidly connected to the output
4 attachment plate.

1 17. The rotary actuator of claim 16 wherein the first link and
2 second links are attached to the actuator shell and output
3 attachment plate, respectively, by quick-change attachment
4 structures.

1 18. The rotary actuator of claim 17 wherein each of the quick-
2 change attachment structures comprises a first radial groove in
3 the structural link, a second radial groove, adjacent to the
4 first radial groove, in the mating portion of the rotary
5 actuator, and a radial clamp, extending about the circumference
6 of the first and second radial grooves.

1 19. The rotary actuator of claim 16 wherein the first
2 structural link is attached to the actuator shell immediately
3 adjacent to the cross-roller bearing and the second structural
4 link is attached to the output attachment plate immediately
5 adjacent to the cross-roller bearing.

1 20. The rotary actuator of claim 15 wherein one or more of the
2 first and second gear portions employs gear teeth having a
3 circular profile.

1 21. The rotary actuator of claim 20 wherein the gear teeth
2 having a circular profile are dimensioned to have a slight
3 interference.

1 22. The rotary actuator of claim 21 wherein one or more of the
2 gear teeth having a circular profile have a cavity disposed
3 therein in order to reduce the stiffness of the gear teeth.

1 23. The rotary actuator of claim 15 wherein 10 or more gear
2 teeth within one or more of the first and second gear portions
3 are in contact at any point in time.